PFRP

Pelagic Fisheries Research Program

Volume 4, Number 3

July–September 1999

New Pacific Bigeye Tuna Projects

In October 1998, the Pelagic Fisheries Research Program solicited new projects to be implemented in 1999. Approximately 25 letters of intent to submit proposal were received. The authors of the most promising letters were invited to submit full research proposals. External scientists reviewed the proposals, and approximately 15 were considered worthy of support. Financial constraints did not permit funding of all the projects. After a painstaking process of elimination, seven projects were selected, and work is expected to begin on these projects in mid 1999. This issue of the PFRP newsletter describes two of these new projects, both directed towards understanding the biology and population and fishery dynamics of Pacific bigeye tuna.

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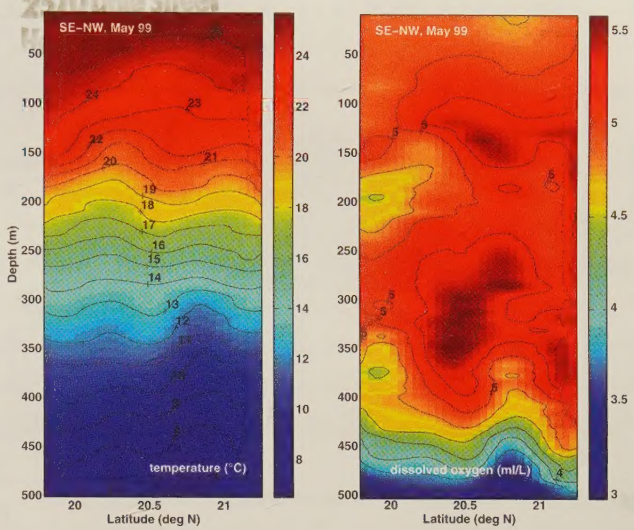

Figure 3. Vertical sections of in situ temperature (°C) along the two transects (SE–NW leg on left, SW–NE leg on right) crossing through the BIGEYE mooring area during May 5 and 6, 1999.

Oceanography's Role in Bigeye Tuna Aggregation and Vulnerability

In Hawaii, bigeye tuna has become the dominant species captured by the locally based longline fishery. It is also the principal deepwater species targeted by the longline fishery in the Pacific Ocean. Annual catches exceed 150,000 tons, and landed values are estimated to be as high as $1.5 billion.

Many different methods have been used to assess bigeye tuna stocks. Each method has used longline fishery catch-per-unit-effort (CPUE) as an index of bigeye abundance. However, fishery-dependent CPUE represents a stock's catchability and not necessarily its abundance.

Catchability of bigeye tuna is influenced to a considerable extent by oceanographic conditions. When current shears are strong, longline gear is generally lifted and unable to penetrate the depths where bigeye tuna are found. On the other hand, convergent flows can result in deepening of the longline gear. Catchability is also influenced by the location of the thermocline.

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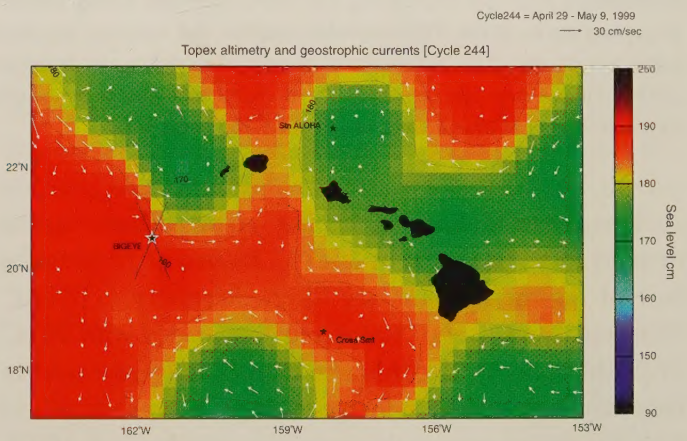

Figure 4. Map of sea level height measured from the TOPEX/Poseidon satellite April 29–May 9, 1999, and velocities of corresponding geostrophic currents (those driven by differences in temperature and salinity). Lines crossing the BIGEYE site illustrate the cruise track of the NOAA ship *Townsend Cromwell* May 5 and 6, 1999.

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Oceanography's Role (continued from page 1)

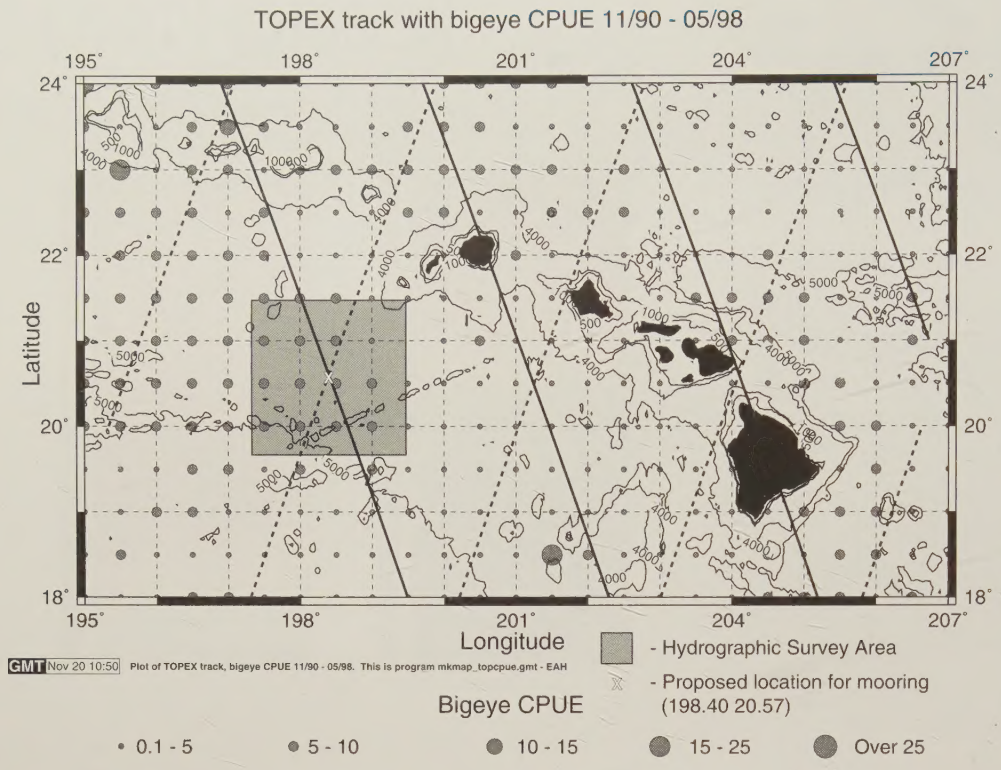

Figure 1. The white X and light gray square indicate the BIGEYE mooring location and hydrographic survey area for shipboard sampling, respectively. The heavy solid and dashed black lines represent the ascending and descending tracks of the TOPEX/Poseidon satellite that measures sea surface height. Note that the BIGEYE mooring is situated at the precise crossover point of ascending and descending tracks. The catch per unit effort (CPUE) of bigeye tuna over the period 11/90–05/98 are indicated by the gray circles (scales at bottom of page represent number of bigeye tunas caught per 1,000 hooks set).

The preferred foraging habitat of the bigeye tuna is thought to be in waters of 8–15°C, located at or near the base of the thermocline (see "Tuna Telemetry in Tahiti," *PFRP* vol. 2, no. 4, and "Recovered Tag Loaded with Data," *PFRP* vol. 3, no. 4). According to recent data, bigeye tuna in Hawaiian waters seem to forage during the day at depths of 350–500 meters (where the water temperature is 8–10°C). The tuna apparently remain at these depths until their body temperature drops to about 17°C (which typically occurs after 45 minutes). The fish then briefly ascend to warmer waters (50–150 meters) before returning to the lower depths.

This behavior suggests that, when the thermocline is depressed or deepened, bigeye tuna may be generally deeper and less aggregated because of their extensive vertical migrations. Although the stock abundance may be unchanged, catchability and CPUE would likely be reduced. Conversely, when the thermocline is elevated, the habitat is generally shallower and the vertical migration less extensive. Bigeye may be more aggregated, resulting in increased catchability and CPUE.

Because stock assessment requires an index of bigeye tuna abundance that is less biased by changes in catchability, the Pelagic Fisheries Research Program (PFRP) is funding a project that will closely examine the relationship between observed oceanographic features and bigeye tuna CPUE from the Hawaii-based longline fishery. The project will use those relationships to develop methods to improve stock assessment estimates. The data will also be used to determine relationships between ocean features and to estimate regions of high velocity and shear, which are likely to reduce the depth penetration of longline gear.

A central component of the project will be an oceanographic mooring established to measure the vertical structure of temperature and current velocity in the bigeye tuna fishing grounds south and west of the main Hawaiian Islands. This BIGEYE mooring will be deployed about 185 km southwest of the island of Niihau at 20°36'N and 161°34.2'W (Figures 1 and 2). This location was selected based on bigeye tuna CPUE, variability of CPUE, proximity to satellite crossover paths, variability of oceanographic structure and linkages to other PFRP projects.

The NOAA research vessel *Townsend Cromwell* will conduct a series of 10- to 14-day trips during the winter-spring months when commercial longline catch and effort for bigeye are highest. On each cruise, measurements of conductivity, temperature and depth will be made about every 15 km along 200 km transect lines centered on the mooring location (Figure 3). Simultaneous acquisition of current profiles will be made from an acoustic Doppler current profiler (ADCP) aboard a vessel and from time-depth recorders (TDRs) placed on longlines deployed from the research vessel. TDRs will also be placed on longlines deployed from commercial longline vessels.

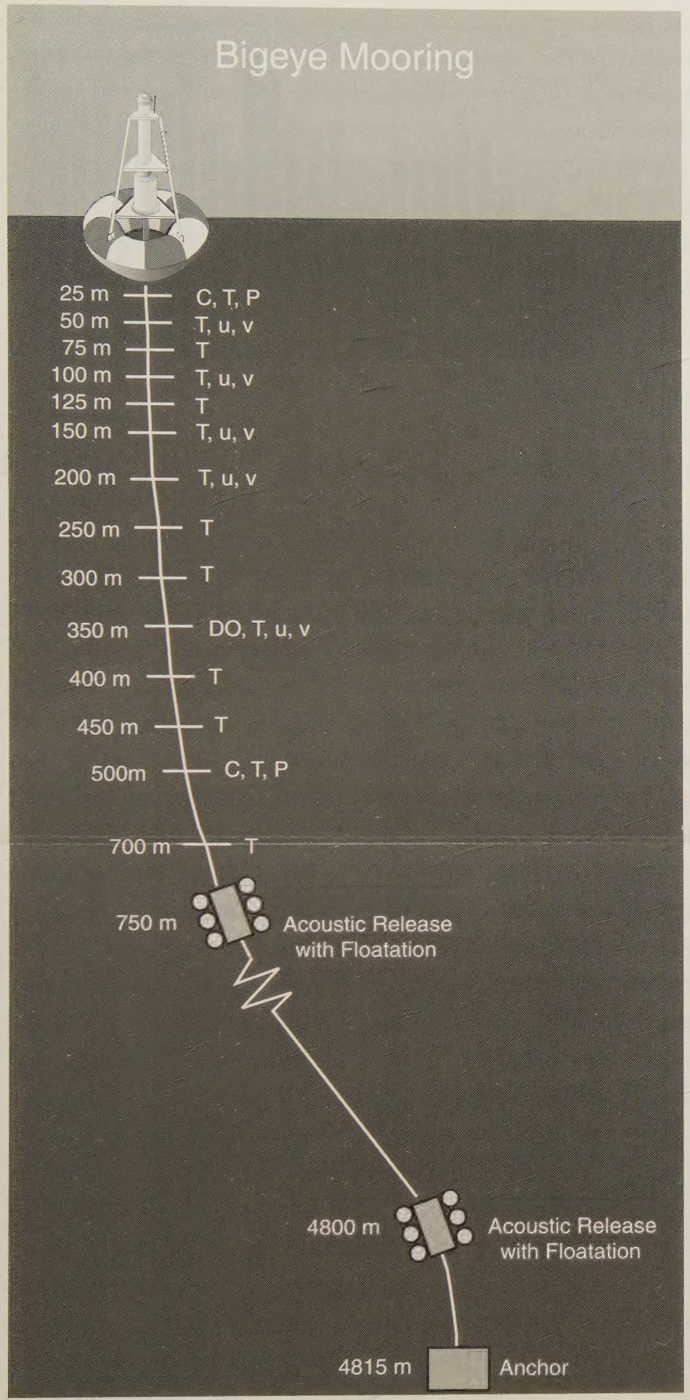

Figure 2. Schematic diagram for the BIGEYE mooring. Abbreviations are as follows: C (conductivity), T (temperature), P (pressure), u (east velocity of current), v (north velocity of current) and DO (dissolved oxygen). [figure courtesy of JIMAR and NOAA]

The biological community of the area will be sampled with a large midwater trawl targeting the depth strata identified as bigeye habitat. In addition, distribution of zooplankton abundance will be mapped using ADCP acoustic backscatter and tows with 200 micron mesh nets.

Data from the mooring and the research cruises will be compared with satellite measurements of the ocean's sea surface height (Figure 4). The comparisons will be used to develop maps that estimate the vertical thermal structure over the fishing grounds every month.

This project hypothesizes that the vertical thermal structure serves as an index or proxy for vertical structure of many physical and biological fields, in particular, of the lower depth limit of bigeye tuna. Estimates of the vertical thermal structure will be used to correct or standardize commercial longline CPUE to better reflect changes in bigeye abundance.

Although this project is designed to examine relationships between bigeye tuna CPUE and oceanographic conditions, the results could be useful in studies of other pelagic species. The research will complement PFRP projects that are investigating yellowfin and bigeye tuna movements and distributions, longline fishery performance, remote sensing technologies, environmental characteristics influencing pelagic fishes, ocean circulation and pelagic fisheries around the Hawaiian Islands, and Pacific broadbill swordfish migration patterns and habitat characteristics. In addition, this research will complement proposed research on marlin, pelagic sharks and the forage base in the Cross Seamount area.

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Pacific-wide Stock Assessment of Bigeye Tuna

Bigeye tuna (*Thunnus obesus*) is an important component of tuna fisheries throughout the Pacific Ocean. It is the principal target species of the large "distant-water" longliners from Japan and Korea, the longline fleet based in Hawaii and the smaller "fresh sashimi" longliners based in several Pacific Island countries. In Hawaii, bigeye tuna is the highest-value component of the longline catch—$17.6 million in landed value in 1997—a trend that is likely to continue as more longline trips in Hawaii target tuna instead of swordfish. Prices paid for both frozen and fresh bigeye on the Japanese sashimi market and in Hawaii are the highest of all the tropical tunas. Bigeye tuna is, therefore, fundamental to the economic well being of the longline fishery in the Pacific Ocean.

The Pacific-wide longline catch of bigeye tuna has varied between 70,000 and 160,000 metric tons (mt) since the 1970s (Figure 1). During this time, catch per unit effort (CPUE) by longliners has declined steadily, particularly in the area east of 160°W where the largest longline catches are taken (Figure 2). Surplus production model analysis based mainly on longline data have suggested that maximum sustainable yield (MSY) may be somewhat less than the maximum observed longline catch, leading to the conclusion that the stock of large bigeye exploited by longliners is at least fully exploited and possibly overexploited. It is probable, however, that the surplus production model is not appropriate for bigeye stock assessment, making the conclusions from surplus production model analysis inconclusive.

Since about 1994, a rapid increase in purse seine catches of juvenile bigeye, first in the eastern Pacific and, in the past two years in the western and central Pacific, has created further uncertainty regarding the sustainability of the current levels of exploitation. Purse seine catches in the eastern Pacific increased from typical levels of less than 10,000 mt per year to approximately 29,000 mt in 1994; 36,000 mt in 1995, and 51,000 mt in 1996 and 1997. These increases have been due to the adoption of new fishing methods that use drifting fish aggregation devices (FADs) and deeper purse seine nets to catch mostly bigeye located deeper in the water column. In the western and central Pacific (west of 150°W), purse seine catches of bigeye are estimated to have been less

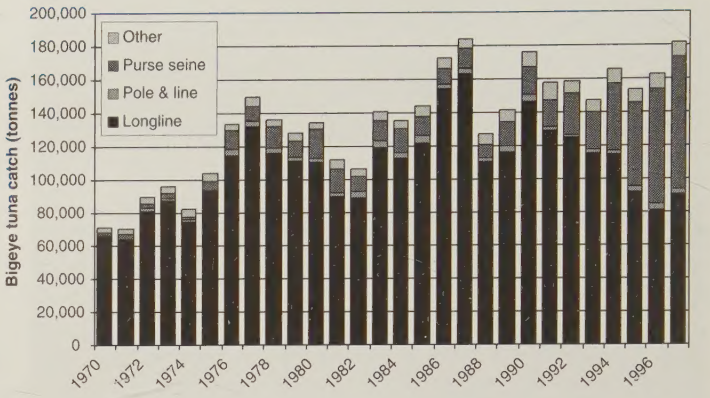

Figure 1. Pacific-wide bigeye tuna catch.

than 15,000 mt in most years up to 1995. In 1996, an estimated 18,000 mt were caught, and in 1997, the estimated catch increased to at least 28,000 mt due to the adoption of fishing techniques similar to those used in the eastern Pacific. Therefore, the Pacific-wide purse seine catch of mostly juvenile bigeye has increased from less than 20,000 mt per year prior to 1992 to almost 80,000 mt in 1997 (Figure 1).

These increases led the 11th Meeting of the Standing Committee on Tuna and Billfish to voice its concerns regarding the impact of present catches on the stock. There is a related concern that purse seine catches, which are processed as low-priced product for canning, will ultimately impact the catches of high-priced, sashimi-quality bigeye by longliners. Such adverse impacts, if they occur, have the potential to reduce the profitability of the longline fishery and, thus, significantly affect the economies of a number of Pacific Island countries.

The uncertainties regarding the impact of the fisheries on the stock and fishery interaction exist for several reasons. First, in the western and central Pacific, estimates of bigeye catches by purse seiners and other surface fisheries are less precise than the catches of the other target species, skipjack and yellowfin tuna. Bigeye catches are not specifically recorded in the fishing logs of many vessels because it is difficult to separate catches of juvenile bigeye and yellowfin (which are of similar appearance) during bulk handling of the catch. Bigeye catches are, therefore, estimated from species composition samples taken at sea by scientific observers or in unloading ports by scientific sampling staff.

In the western and central Pacific, the coverage of purse seine trips by observer or port-based sampling is relatively low, which introduces unavoidable sampling errors into the catch estimates. This problem is much less serious in the eastern Pacific, where the fleet of large purse seiners is subjected to 100 percent observer coverage. Uncertainty also results because aspects of bigeye tuna biology—such as stock structure, east-west population mixing and natural mortality rates—are not understood, so the response of the stock to fishing pressure cannot be accurately predicted.

A new study funded by the Pelagic Fisheries Research Project will soon address these problems by analyzing available bigeye tuna catch, effort, size composition and tagging data from throughout the Pacific Ocean. The project, the first of its type on such a large scale, will involve collaboration of the Secretariat of the Pacific Community (Oceanic Fisheries Program), the Inter-American Tropical Tuna Commission and the Japan National Research Institute of Far Seas Fisheries.

Using a model to study the population dynamics of bigeye tuna, collaborators anticipate the following outputs: estimates of recruitment, population biomass, adult biomass and fishing mortality for each sub-region defined in the model; growth parameters; natural mortality rates (by age class if appropriate), and movement parameters. Collaborators also intend to compare current and future adult biomass to a pre-determined reference. If adult biomass falls below the pre-determined level, it would act as

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Upcoming Events

August 9–13

Pacific Community Heads of Fisheries Meeting (RTMF)
Nouméa, New Caledonia.
Secretariat of the Pacific Community (SPC)
BP D5, 98848 Noumea Cedex, New Caledonia
(687) 262000 (s/b) or 260124; fax (687) 263818
e-mail tima@spc.org.nc or helenel@spc.org.nc
http://www.spc.org.nc/coastfish/reports/rtmf27/index.htm

September 6–15

5th Multilateral High Level Consultation (MHLC5) on the Development of Arrangements for the Management and Conservation of Western Tropical Pacific Stocks of Highly Migratory Fishes
Honolulu, Hawaii, USA
Barbara Hanchard for the MHLC Conference Secretariat; e-mail barbara.hanchard@ffa.int

October 8–17

North Pacific Marine Science Organization (PICES) Eighth Annual Meeting
Vladivostok. Institute of Ocean Sciences
P.O. Box 6000, Sidney, B.C., Canada V8L 4B2
(250) 363-6366; fax (250) 363-6827
e-mail pices@ios.bc.ca
http://pices.ios.bc.ca

October 27–30

17th Lowell Wakefield Fisheries Symposium on Spatial Processes and Management of Fish Populations
Anchorage, Alaska, USA
Brenda Baxter, Coordinator, Alaska Sea Grant College Program, University of Alaska Fairbanks
P.O. Box 755040, Fairbanks, AK 99775-5040
(907) 474-6701; fax (907) 474-6285
e-mail FNBRB@uaf.edu
http://www.uaf.edu/seagrant/Conferences/symposia.html

October 15–19

Tuna Fishing and Fish Aggregating Devices Symposium
Martinique, French Antilles
Marc TAQUET, IFREMER, Délégation Antilles
Pointe Fort 97231- Le Robert - Martinique
Antilles Françaises.
(596) 657909; fax (596) 651156
e-mail Marc.Taquet@ifremer.fr
http://www.ifremer.fr/general/colloque

Pacific-wide Stock Assessment (continued from page 5)

a trigger for management action. It will also be possible to use the model to measure interactions among the different fisheries and to indicate areas where additional data (including biological data) would increase the certainty of future assessments.

This information will greatly assist regional management initiatives and help the Western Pacific Regional Fisheries Management Council to design domestic management measures that are compatible with any future regional management action.

The project collaborators had their first meeting in June in Tahiti, in association with the 12th meeting of the Standing Committee on Tuna and Billfish.

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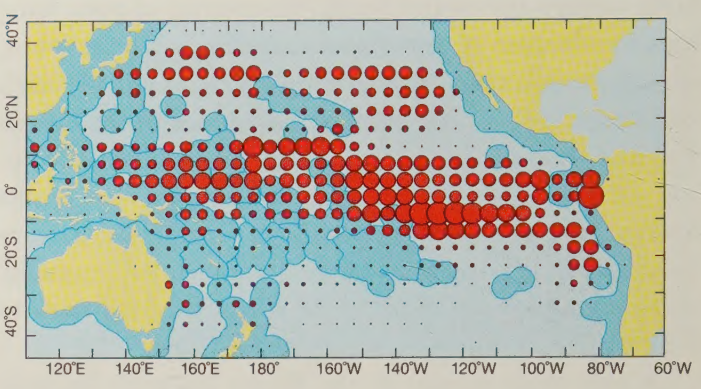

Figure 2. Bigeye tuna longline catch.

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